

**567—43.5(455B) Filtration and disinfection for surface water and influenced groundwater public water supply systems.****43.5(1) Applicability/general requirements.**

a. These rules apply to all public water supply systems using surface water or groundwater under the direct influence of surface water, in whole or in part, and establish criteria under which filtration is required as a treatment technique. In addition, these rules establish treatment technique requirements in lieu of maximum contaminant levels for *Giardia lamblia*, heterotrophic plate count bacteria, *Legionella*, viruses and turbidity. Each public water system with a surface water source or a groundwater source under the direct influence of surface water must provide treatment of that source water which complies with these treatment technique requirements. Systems which serve at least 10,000 persons must also comply with the requirements of 567—43.9(455B). Systems which serve fewer than 10,000 persons must also comply with the requirements of 567—43.10(455B). The treatment technique requirements consist of installing and properly operating water treatment processes which reliably achieve:

(1) At least 99.9 percent (3-log) removal or inactivation of *Giardia lamblia* cysts between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer; and

(2) At least 99.99 percent (4-log) removal or inactivation of viruses between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer.

b. Criteria for identification of groundwater under the direct influence of surface water. “Groundwater under the direct influence of surface water” means any water beneath the surface of the ground with: (1) significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia*, or (2) significant and relatively rapid shifts in water characteristics such as turbidity (particulate content), temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. Direct influence must be determined for individual sources in accordance with criteria established by the department. The department determination of direct influence may be based on site-specific measurements of water quality or documentation of well construction characteristics and geology with field evaluation. Only surface water and groundwater sources under the direct influence of surface water that are at risk to the contamination from *Giardia* cysts are subject to the requirements of this rule. Groundwater sources shall not be subject to this rule. The evaluation process shall be used to delineate between surface water, groundwater under the direct influence of surface water and groundwater. The identification of a source as surface water and groundwater under the direct influence of surface water shall be determined for an individual source, by the department, in accordance with the following criteria. The public water supply shall provide to the department that information necessary to make the determination. The evaluation process will involve one or more of the following steps:

(1) Preliminary evaluation. The department shall conduct a preliminary evaluation of information on the source provided by the public water supply to determine if the source is an obvious surface water (e.g., pond, lake, stream) or groundwater under the direct influence of surface water. The source shall be evaluated during that period of highest susceptibility to influence from surface water. The preliminary evaluation may include a review of surveys, reports, geological information of the area, physical properties of the source, and a review of departmental and public water system records. If the source is identified as a surface water, no additional evaluation shall be conducted. If the source is a groundwater and identified as a deep well, it shall be classified as a groundwater not under the direct influence of surface water and no additional evaluation shall be conducted, unless through direct knowledge or documentation the source does not meet the requirements of 43.5(1) “b”(2). The deep well shall then be evaluated in accordance with 43.5(1) “b”(3). If the source is a shallow well, the source shall be evaluated in accordance with 43.5(1) “b”(2). If the source is a spring, infiltration gallery, radial collector well, or any other subsurface source, it shall be evaluated in accordance with 43.5(1) “b”(3).

(2) Well source evaluation. Shallow wells greater than 50 feet in lateral distance from a surface water source shall be evaluated for direct influence of surface water through a review of departmental or public water system files in accordance with 43.5(1) “b”(2)“1” and 43.5(1) “b”(2)“2.” Sources that

meet the criteria shall be considered to be not under the direct influence of surface water. No additional evaluation will be required. Shallow wells 50 feet or less in lateral distance from a surface water shall be in accordance with 43.5(1) "b"(3) and (4).

1. Well construction criteria. The well shall be constructed so as to prevent surface water from entering the well or traversing the casing.

2. Water quality criteria. Water quality records shall indicate:

- No record of total coliform or fecal coliform contamination in untreated samples collected over the past three years.
- No history of turbidity problems associated with the well, other than turbidity as a result of inorganic chemical precipitates.
- No history of known or suspected outbreak of *Giardia* or other pathogenic organisms associated with surface water (e.g., *Cryptosporidium*) which has been attributed to the well.

3. Other available data. If data on particulate matter analysis of the well are available, there shall be no evidence of particulate matter present that is associated with surface water. If information on turbidity or temperature monitoring of the well and nearby surface water is available, there shall be no data on the source which correlates with that of a nearby surface water.

4. Further evaluation. Wells that do not meet all the requirements listed shall require further evaluation in accordance with 43.5(1) "b"(3) and (4).

(3) Formal evaluation. The evaluation shall be conducted by the department or a licensed professional engineer at the direction of the public water supply. The evaluation shall include:

1. Complete file review. In addition to the information gathered in 43.5(1) "b"(1), the complete file review shall consider but not be limited to: design and construction details; evidence of direct surface water contamination; water quality analysis; indications of waterborne disease outbreaks; operational procedures; and customer complaints regarding water quality or water-related infectious illness. Sources other than a well source shall be evaluated in a like manner to include a field survey.

2. Field survey. A field survey shall substantiate findings of the complete file review and determine if the source is at risk to pathogens from direct surface water influence. The field survey shall examine the following criteria for evidence that surface water enters the source through defects in the source which include but are not limited to: a lack of a surface seal on wells, infiltration gallery laterals exposed to surface water, springs open to the atmosphere, surface runoff entering a spring or other collector, and distances to obvious surface water sources.

A report summarizing the findings of the complete file review and field survey shall be submitted to the department for final review and classification of the source. If the complete file review or field survey demonstrates conclusively that the source is subject to the direct surface water influence, the source shall be classified as under the direct influence of surface water. Either method or both may be used to demonstrate that the source is a surface water or groundwater under the direct influence of surface water. If the findings do not demonstrate conclusive evidence of direct influence of surface water, the analysis outlined in 43.5(1) "b"(4) should be conducted.

(4) Particulate analysis and physical properties evaluation.

1. Surface water indicators. Particulate analysis shall be conducted to identify organisms which only occur in surface waters as opposed to groundwaters, and whose presence in a groundwater would indicate the direct influence of surface water.

- Identification of a *Giardia* cyst, live diatoms, and blue-green, green, or other chloroplast containing algae in any source water shall be considered evidence of direct surface water influence.

- Rotifers and insect parts are indicators of surface water. Without knowledge of which species is present, the finding of rotifers indicates that the source is either directly influenced by surface water, or the water contains organic matter sufficient to support the growth of rotifers. Insects or insect parts shall be considered strong evidence of surface water influence, if not direct evidence.

- The presence of coccidia (e.g., *Cryptosporidium*) in the source water is considered a good indicator of direct influence of surface water. Other macroorganisms (greater than 7  $\mu$ m) which are parasitic to animals and fish such as, but not limited to, helminths (e.g., tapeworm cysts), ascaris, and *Diphyllobothrium*, shall be considered as indicators of direct influence of surface water.

2. Physical properties. Turbidity, temperature, pH and conductivity provide supportive, but less direct, evidence of direct influence of surface water. Turbidity fluctuations of greater than 0.5-1.0 NTU over the course of a year may be indicative of direct influence of surface water. Temperature fluctuations may also indicate surface water influence. Changes in other chemical parameters such as pH, conductivity, or hardness may also give an indirect indication of influence by nearby surface water.

c. Compliance. A public water system using a surface water source or a groundwater source under the direct influence of surface water is considered to be in compliance with the requirements of this subrule if it meets the filtration requirements in 43.5(3) and the disinfection requirements in 43.5(2) in accordance with the effective dates specified within the respective subrules.

d. Certified operator requirement. Each public water system using a surface water source or a groundwater source under the direct influence of surface water must be operated by a certified operator who meets the requirements of 567—Chapter 81.

**43.5(2) Disinfection.** All community and noncommunity public water supply systems using surface water or groundwater under the direct influence of surface water in whole or in part shall be required to provide disinfection in compliance with this subrule and filtration in compliance with 43.5(3). If the department has determined that filtration is required, the system must comply with any interim disinfection requirements the department deems necessary before filtration is installed. A system providing filtration on or before December 30, 1991, must meet the disinfection requirements of this subrule beginning June 29, 1993. A system providing filtration after December 30, 1991, must meet the disinfection requirements of this subrule when filtration is installed. Failure to meet any requirement of this subrule after the applicable date specified in this subrule is a treatment technique violation. The disinfection requirements are as follows:

a. *Disinfection treatment criteria.* The disinfection treatment must be sufficient to ensure that the total treatment processes of that system achieve at least 99.9 percent (3-log) inactivation or removal of *Giardia lamblia* cysts and at least 99.99 percent (4-log) inactivation or removal of viruses, acceptable to the department. At least 0.5 log inactivation of *Giardia lamblia* cysts must be achieved through disinfection treatment using a chemical disinfectant even if the required inactivation or removal is met or exceeded through physical treatment processes. Each system is required to calculate the total inactivation ratio ( $CT_{\text{calculated}}/CT_{\text{required}}$ ) each day the treatment plant is in operation. The system's total inactivation ratio must be equal to or greater than 1.0 in order to ensure that the minimum inactivation and removal requirements have been achieved. If the system's total inactivation ratio for the day is below 1.0, the system must notify the department within 24 hours.

b. *Disinfection system.* The disinfection system must include:

(1) Redundant components, including an auxiliary power supply with automatic start-up and alarm to ensure that disinfectant application is maintained continuously while water is being delivered to the distribution system, or

(2) Automatic shutoff of delivery of water to the distribution system whenever there is less than 0.3 mg/L of residual disinfectant concentration in the water. If the department determines that automatic shutoff would cause unreasonable risk to health or interfere with fire protection, the system must comply with 43.5(2) "b"(1).

c. *Residual disinfectant entering system.* The residual disinfectant concentration in the water entering the distribution system, measured as specified in 43.5(4) "a"(5) and 43.5(4) "b"(2), cannot be less than 0.3 mg/L free residual or 1.5 mg/L total residual chlorine for more than four hours.

d. *Residual disinfectant in the system.* The residual disinfectant concentration in the distribution system, measured as total chlorine, combined chlorine, or chlorine dioxide, as specified in 43.5(4) "a"(5) and 43.5(4) "b"(2), cannot be undetectable in more than 5 percent of the samples each month for any two consecutive months that the system serves water to the public. Water within the distribution system with a heterotrophic plate count bacteria concentration less than or equal to 500/mL, measured as heterotrophic plate count (HPC) as specified in 567—paragraph 41.2(3) "e," is deemed to have a detectable disinfectant residual for purposes of determining compliance with this requirement. Therefore, the value "V" in the following formula cannot exceed 5 percent in one month for any two consecutive months.

$$V = \left[ \frac{c + d + e}{a + b} \right] \times 100$$

where:

- a = number of instances in which the residual disinfectant concentration is measured;
- b = number of instances in which the residual disinfectant concentration is not measured but heterotrophic plate count bacteria (HPC) is measured;
- c = number of instances in which the residual disinfectant concentration is measured but not detected and no HPC is measured;
- d = number of instances in which no residual disinfectant concentration is detected and where the HPC is greater than 500/mL; and
- e = number of instances in which the residual disinfectant concentration is not measured and HPC is greater than 500/mL.

### 43.5(3) *Filtration.*

a. *Applicability.* A public water system that uses a surface water source or a groundwater source under the direct influence of surface water must provide treatment consisting of both disinfection, as specified in 43.5(2), and filtration treatment which complies with the turbidity requirements of subrules 43.5(3), 43.5(4), and 43.5(5). A system providing or required to provide filtration on or before December 30, 1991, must meet the requirements of this subrule by June 29, 1993. A system providing or required to provide filtration after December 30, 1991, must meet the requirements of this subrule when filtration is installed. Beginning January 1, 2002, systems serving at least 10,000 people must meet the turbidity requirements in 567—43.9(455B). Beginning January 1, 2005, systems serving fewer than 10,000 people must meet the turbidity requirements in 567—43.10(455B). A system shall install filtration within 18 months after the department determines, in writing, that filtration is required. The department may require and the system shall comply with any interim turbidity requirements the department deems necessary. Failure to meet any requirements of the referenced subrules after the dates specified is a treatment technique violation.

#### b. *Conventional filtration treatment or direct filtration.*

(1) For systems using conventional filtration or direct filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 0.5 nephelometric turbidity units (NTU) in at least 95 percent of the measurements taken each month when measured as specified in 43.5(4) "a"(1) and 43.5(4) "b"(1).

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU when measured as specified in 43.5(4) "a"(1) and 43.5(4) "b"(1).

#### c. *Slow sand filtration.*

(1) For systems using slow sand filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month when measured as specified in 43.5(4) "a"(1) and 43.5(4) "b"(1).

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU when measured as specified in 43.5(4) "a"(1) and 43.5(4) "b"(1).

#### d. *Diatomaceous earth filtration.*

(1) For systems using diatomaceous earth filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month when measured as specified in 43.5(4) "a"(1) and 43.5(4) "b"(1).

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU when measured as specified in 43.5(4) "a"(1) and 43.5(4) "b"(1).

e. *Other filtration technologies.* A public water system may use either a filtration technology not listed in 43.5(3) "b" to 43.5(3) "d" or a filtration technology listed in 43.5(3) "b" or 43.5(3) "c" at a higher turbidity level if it demonstrates to the department through a preliminary report submitted

by a licensed professional engineer, using pilot plant studies or other means, that the alternative filtration technology in combination with disinfection treatment that meets the requirements of 43.5(2) consistently achieves 99.9 percent removal or inactivation of *Giardia lamblia* and 99.99 percent removal or inactivation of viruses. For a system that uses alternative filtration technology and makes this demonstration, the turbidity treatment technique requirements are as follows:

(1) The turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month when measured as specified in 43.5(4) "a"(1) and 43.5(4) "b"(1).

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU when measured as specified in 43.5(4) "a"(1) and 43.5(4) "b"(1).

Beginning January 1, 2002, systems serving at least 10,000 people must meet the requirements for other filtration technologies in 43.9(3) "b."

Beginning January 1, 2005, systems serving fewer than 10,000 people must meet the requirements for other filtration technologies in 567—43.10(455B).

**43.5(4) Analytical and monitoring requirements.**

*a. Analytical requirements.* Only the analytical method(s) specified in this paragraph, or otherwise approved by the department, may be used to demonstrate compliance with the requirements of 43.5(2) and 43.5(3). Measurements for pH, temperature, turbidity, and residual disinfectant concentrations must be conducted by a Grade II, III or IV operator meeting the requirements of 567—Chapter 81, any person under the supervision of a Grade II, III or IV operator meeting the requirements of 567—Chapter 81, or a laboratory certified by the department to perform analysis under 567—Chapter 83. For consecutive public water supplies from a surface water or groundwater under the direct influence of surface water system, the disinfectant concentration analyses must be conducted by a certified operator who meets the requirements of 567—Chapter 81. Measurements for heterotrophic plate count bacteria must be conducted by a laboratory certified by the department to do such analysis.

(1) Turbidity analytical methodology. Turbidity analysis shall be conducted using the methodology in the following table. Each turbidimeter must be calibrated at least once every 90 days with a primary standard. The calibration of each turbidimeter used for compliance must be verified at least once per week with a primary standard, secondary standards, or the manufacturer's proprietary calibration confirmation device or by a method approved by the department. If the verification is not within plus or minus 0.05 NTU for measurements of less than or equal to 0.5 NTU, or within plus or minus 10 percent of measurements greater than 0.5 NTU, the turbidimeter must be recalibrated.

Methodology	Analytical Method				
	EPA	SM	GLI	HACH	Other
Nephelometric <sup>5</sup>	180.1 <sup>1</sup>	2130B <sup>2</sup>	Method 2 <sup>3</sup>	FilterTrak 10133 <sup>4</sup>	
Laser Nephelometry (online)					Mitchell M5271 <sup>6</sup> ; Mitchell M5331 Rev. 1.2 <sup>10</sup>
LED Nephelometry (online)					Mitchell M53317; Mitchell M5331 Rev. 1.2 <sup>10</sup> ; AMI Turbiwell <sup>9</sup>
LED Nephelometry (portable)					Orion AQ4500 <sup>8</sup>
360-degree Nephelometry					Hach Method 10258 <sup>11</sup>

<sup>1</sup>"Methods for the Determination of Inorganic Substances in Environmental Samples," EPA-600/R-93-100, August 1993. Available at NTIS, PB94-121811.

<sup>2</sup>Standard Methods for the Examination of Water and Wastewater, 18th edition, 1992, 19th edition, 1995, 20th edition, 1998, 21st edition, 2005, and 22nd edition, 2012 (any of these editions may be used), American Public Health Association, 800 I Street, NW, Washington, DC 20001-3710.

<sup>3</sup>GLI Method 2, “Turbidity,” November 2, 1992, Great Lakes Instruments, Inc., 8855 North 55th Street, Milwaukee, WI 53223.

<sup>4</sup>Hach FilterTrak Method 10133, “Determination of Turbidity by Laser Nephelometry,” January 2000, Revision 2.0, Hach Co., P.O. Box 389, Loveland, CO 80539-0389, telephone (800)227-4224.

<sup>5</sup>Styrene divinyl benzene beads (e.g., AMCO-AEPA-1 or equivalent) and stabilized formazin (e.g., Hach StablCal™ or equivalent) are acceptable substitutes for formazin.

<sup>6</sup>Mitchell Method M5271, Revision 1.1. “Determination of Turbidity by Laser Nephelometry,” March 5, 2009. Available at [www.nemi.gov](http://www.nemi.gov) or from Leck Mitchell, 656 Independence Valley Drive, Grand Junction, CO 81507.

<sup>7</sup>Mitchell Method M5331, Revision 1.1. “Determination of Turbidity by LED Nephelometry,” March 5, 2009. Available at [www.nemi.gov](http://www.nemi.gov) or from Leck Mitchell, 656 Independence Valley Drive, Grand Junction, CO 81507.

<sup>8</sup>Orion Method AQ4500, Revision 1.0. “Determination of Turbidity by LED Nephelometry,” May 8, 2009. Available at [www.nemi.gov](http://www.nemi.gov) or from Thermo Scientific, 166 Cummings Center, Beverly, MA 01915, [www.thermo.com](http://www.thermo.com).

<sup>9</sup>AMI Turbiwell, “Continuous Measurement of Turbidity Using a SWAN AMI Turbiwell Turbidimeter,” August 2009. Available at [www.nemi.gov](http://www.nemi.gov) or from Markus Bernasconi, SWAN Analytische Instrumente AG, Studbachstrasse 13, CH-8340 Hinwil, Switzerland.

<sup>10</sup>Mitchell Method M5331, Revision 1.2. “Determination of Turbidity by LED or Laser Nephelometry,” February 2016. Available from Leck Mitchell, 656 Independence Valley Drive, Grand Junction, CO 81507.

<sup>11</sup>Hach Company. “Hach Method 10258 – Determination of Turbidity by 360-Degree Nephelometry,” January 2016. Available at [www.hach.com](http://www.hach.com).

(2) Temperature analytical methodology. The temperature shall be determined in compliance with the methodology listed in 567—subparagraph 41.4(1)“g”(1).

(3) pH (hydrogen ion concentration) analytical methodology. The pH shall be determined in compliance with the methodology listed in 567—subparagraph 41.4(1)“g”(1).

(4) Heterotrophic plate count bacteria analytical methodology. The heterotrophic plate count bacteria sampling and analysis shall be conducted in compliance with 567—subrule 41.2(3) and 43.5(2)“d.” The time from sample collection to initiation of analysis shall not exceed eight hours, and the samples must be held below 10 degrees C during transit.

(5) Residual disinfectant analytical methodology. The residual disinfectant concentrations shall be determined in compliance with one of the analytical methods in the following table. Residual disinfectant concentrations for free chlorine and combined chlorine may also be measured by using DPD colorimetric test kits. Free and total chlorine residuals may be measured continuously by adapting a specified chlorine residual method for use with a continuous monitoring instrument provided the chemistry, accuracy and precision remain the same. Instruments used for continuous monitoring must be verified with a grab sample measurement at least every seven days. The analyzer concentration must be within plus or minus 0.1 mg/L or plus or minus 15 percent (whichever is larger) of the grab sample measurement. If the verification is not within this range, immediate actions must be taken to resolve the issue and another verification must be conducted.

### Disinfectant Analytical Methodology

Residual	Methodology	Standard Methods <sup>1,2</sup>	Standard Methods Online <sup>6</sup>	Other
Free chlorine	Amperometric Titration DPD Ferrous Titrimetric DPD Colorimetric Syringaldazine (FACTS) Online Chlorine Analyzer Amperometric Sensor Indophenol Colorimetric	4500-Cl D 4500-Cl F 4500-Cl G 4500-Cl H	4500-Cl D-00 4500-Cl F-00 4500-Cl G-00 4500-Cl H-00	D1253-03 <sup>4</sup> , 08, 14  Hach Method 10260 <sup>10</sup>  EPA 334.0 <sup>7</sup> ChloroSense <sup>8</sup> Hach Method 10241 <sup>11</sup>
Total chlorine	Amperometric Titration Amperometric Titration (low-level measurement) DPD Ferrous Titrimetric DPD Colorimetric Iodometric Electrode Online Chlorine Analyzer Amperometric Sensor	4500-Cl D 4500-Cl E 4500-Cl F 4500-Cl G 4500-Cl I	4500-Cl D-00 4500-Cl E-00 4500-Cl F-00 4500-Cl G-00 4500-Cl I-00	D1253-03 <sup>4</sup> , 08, 14   Hach Method 10260 <sup>10</sup>  EPA 334.0 <sup>7</sup> ChloroSense <sup>8</sup>
Chlorine dioxide	Amperometric Titration DPD Method Amperometric Titration Amperometric Sensor Spectrophotometric	4500-ClO <sub>2</sub> C 4500-ClO <sub>2</sub> D 4500-ClO <sub>2</sub> E	4500-C10 <sub>2</sub> C-00  4500-C10 <sub>2</sub> E-00	   ChlordioX Plus <sup>9</sup> 327.0, Revision 1.1 <sup>5</sup>
Ozone	Indigo method	4500-O <sub>3</sub> B <sup>3</sup>	4500-O <sub>3</sub> B-97	

<sup>1</sup>Standard Methods for the Examination of Water and Wastewater, 18th edition, 1992, 19th edition, 1995, 20th edition, 1998, 21st edition, 2005, or 22nd edition, 2012 (any of these editions may be used), American Public Health Association, 800 I Street, NW, Washington, DC 20001-3710. Only the 18th, 19th, and 20th editions may be used for chlorine dioxide Method 4500-ClO<sub>2</sub> D.

<sup>2</sup>Other analytical test procedures are contained within Technical Notes on Drinking Water Methods, EPA-600/R-94-173, October 1994, which is available as NTIS PB95-104766.

<sup>3</sup>Standard Methods for the Examination of Water and Wastewater, 18th edition (1992), 19th edition (1995), 21st edition (2005), and 22nd edition (2012) (any edition may be used); American Public Health Association, 800 I Street, NW, Washington, DC 20001-3710.

<sup>4</sup>Annual Book of ASTM Standards, Vol. 11.01, 2004; ASTM International; any year containing the cited version of the method may be used. Copies of this method may be obtained from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

<sup>5</sup>EPA Method 327.0, Revision 1.1, "Determination of Chlorine Dioxide and Chlorite Ion in Drinking Water Using Lissamine Green B and Horseradish Peroxidase with Detection by Visible Spectrophotometry," US EPA, May 2005, EPA 815-R-05-008. Available online at [www.nemi.gov](http://www.nemi.gov).

<sup>6</sup>Standard Methods Online is available at [www.standardmethods.org](http://www.standardmethods.org). The year in which each method was approved by the Standard Methods Committee is designated by the last two digits in the method number. The methods listed are the only online versions that may be used.

<sup>7</sup>EPA Method 334.0, "Determination of Residual Chlorine in Drinking Water Using an On-Line Chlorine Analyzer," August 2009. EPA 815-B-09-013. Available at [www.nemi.gov](http://www.nemi.gov).

<sup>8</sup>ChloroSense, "Measurement of Free and Total Chlorine in Drinking Water by Palintest ChloroSense," September 2009. Available at [www.nemi.gov](http://www.nemi.gov) or from Palintest Ltd., 21 Kenton Lands Road, P.O. Box 18395, Erlanger, KY 41018.

<sup>9</sup>ChlordioX Plus. "Chlorine Dioxide and Chlorite in Drinking Water by Amperometry Using Disposable Sensors," November 2013. Available from Palintest Ltd., Jamike Avenue (Suite 100), Erlanger, KY 41018.

<sup>10</sup>Hach Company. "Hach Method 10260 – Determination of Chlorinated Oxidants (Free and Total) in Water Using Disposable Planar Reagent-Filled Cuvettes and Mesofluidic Channel Colorimetry," April 2013. Available at [www.hach.com](http://www.hach.com).

<sup>11</sup>Hach Company. "Hach Method 10241 – Spectrophotometric Measurement of Free Chlorine in Finished Drinking Water," November 2015, Revision 1.2. Available at [www.hach.com](http://www.hach.com).

*b. Monitoring requirements.* A public water system that uses a surface water source or groundwater source under the influence of surface water must monitor in accordance with this paragraph.

(1) Turbidity.

1. Routine turbidity monitoring requirements. Turbidity measurements as required by 43.5(3) must be performed on representative samples of the system's filtered water every four hours (or more frequently as long as measurements are recorded at equal time intervals and detailed in the turbidity protocol) that the system serves water to the public. A public water system may substitute continuous turbidity monitoring for grab sample monitoring or may monitor more frequently than every four hours if it validates the continuous measurement for accuracy on a regular basis using a turbidity protocol approved by the department and audited for compliance during sanitary surveys. Major elements of the protocol shall include, but are not limited to: sample measurement location, method of calibration, calibration frequency, calibration standards, method of verification, verification frequency, documentation, data collection, data recording frequency, and data reporting. For any systems using slow sand filtration or filtration treatment other than conventional treatment, direct filtration, or diatomaceous earth filtration, the department may reduce the sampling frequency to once per day if it determines that less frequent monitoring is sufficient to indicate effective filtration performance. For systems serving 500 or fewer persons, the department may reduce the turbidity sampling frequency to once per day, regardless of the type of filtration treatment used, if the department determines that less frequent monitoring is sufficient to indicate effective filtration performance. Approval shall be based upon documentation provided by the system, acceptable to the department and pursuant to the conditions of an operation permit.

2. Turbidity monitoring requirements for population greater than 100,000. A supplier of water serving a population or population equivalent of greater than 100,000 persons shall provide a continuous or rotating cycle turbidity monitoring and recording device or take hourly grab samples to determine

compliance with 43.5(3). The system must meet the requirements in 43.5(4) “b”(1)“1,” including the turbidity protocol.

3. Failure of the continuous turbidity monitoring equipment. If there is a failure in the continuous turbidity monitoring equipment, the system must conduct grab sampling every four hours in lieu of continuous monitoring until the turbidimeter is repaired and back online. A system has a maximum of five working days after failure to repair the equipment or else the system is in violation. The system must notify the department within 24 hours of both when the turbidimeter was taken offline and when it was returned online.

(2) Residual disinfectant.

1. Residual disinfectant entering the system. The residual disinfectant concentration of the water entering the distribution system shall be monitored continuously, and the lowest value recorded each day, except that if there is a failure in the continuous monitoring equipment, grab sampling every four hours may be conducted in lieu of continuous monitoring, but not to exceed five working days following the failure of the equipment. If acceptable to the department, systems serving 3,300 or fewer persons may take grab samples in lieu of providing continuous monitoring on an ongoing basis at the frequencies prescribed below:

Residual Disinfectant Samples Required of Surface Water or IGW PWS

System size (persons served)	Samples per day*
500 or fewer	1
501 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4

\*When more than one grab sample is required per day, the day’s samples cannot be taken at the same time. The sampling intervals must be at a minimum of four-hour intervals.

If at any time the disinfectant concentration falls below 0.3 mg/L free residual or 1.5 mg/L total residual chlorine in a system using grab sampling in lieu of continuous monitoring, the system shall take a grab sample every four hours until the residual disinfectant concentration is equal to or greater than 0.3 mg/L free residual or 1.5 mg/L total residual chlorine.

2. Residual disinfectant in the system. The residual disinfectant concentration must be measured at least daily in the distribution system. Residual disinfectant measurements that are required as part of the total coliform bacteria sample collection under 567—subparagraph 41.2(1)“c”(7) shall be used to satisfy this requirement on the day(s) when a bacteria sample(s) is collected. The department may allow a public water system that uses both a groundwater source and a surface water source or a groundwater source under direct influence of surface water to take residual disinfectant samples at points other than the total coliform sampling points, if these points are included as a part of the coliform sample site plan meeting the requirements of 567—paragraph 41.2(1)“c”(1)“1” and if the department determines that such points are representative of treated (disinfected) water quality within the distribution system. Heterotrophic plate count bacteria (HPC) may be measured in lieu of residual disinfectant concentration, using the analytical methods specified in 567—subparagraph 41.2(3)“e”(1). The time from sample collection to initiation of analysis shall not exceed eight hours. HPC samples must be kept below 10 degrees C during transit to the laboratory. All HPC samples must be analyzed by a department-certified laboratory meeting the requirements of 567—Chapter 83.

**43.5(5) Reporting requirements.** Public water supplies shall report the results of routine monitoring required to demonstrate compliance with 567—43.5(455B) and treatment technique violations as follows:

a. *Waterborne disease outbreak.* Each system, upon discovering that a waterborne disease outbreak potentially attributable to that water system has occurred, must report that occurrence to the department as soon as possible, but no later than by the end of the next business day.

*b. Turbidity exceeds 5 NTU.* If at any time the turbidity exceeds 5 NTU, the system must inform the department as soon as possible, but no later than 24 hours after the exceedance is known, in accordance with the public notification requirements under 567—subparagraph 42.1(3)“b”(3).

*c. Residual disinfectant entering distribution system below 0.3 mg/L free residual chlorine or 1.5 mg/L total residual chlorine.* If at any time the residual falls below 0.3 mg/L free residual chlorine or 1.5 mg/L total residual chlorine in the water entering the distribution system, the system must notify the department as soon as possible, but no later than by the end of the next business day. The system also must notify the department by the end of the next business day whether or not the residual was restored to at least 0.3 mg/L free residual chlorine or 1.5 mg/L total residual chlorine within four hours.

*d. Routine monitoring reporting requirements.* Routine monitoring results shall be provided as part of the monthly operation reports in accordance with 567—40.3(455B) and 567—subrule 42.4(3).

*e. Total inactivation ratio below 1.0.* If the system’s total inactivation ratio for the day is below 1.0, the system must notify the department within 24 hours.

**43.5(6) Filter backwash recycle provisions.** All surface water or influenced groundwater systems that employ conventional filtration or direct filtration treatment and that recycle spent filter backwash water, thickener supernatant, or liquids from dewatering processes must meet the requirements of this subrule.

*a. Reporting.* A system must notify the department in writing by December 8, 2003, if the system recycles spent filter backwash water, thickener supernatant, or liquids from dewatering processes. This notification must include the following information at a minimum:

(1) A plan schematic showing the origin of all flows which are recycled (including, but not limited to, spent filter backwash water, thickener supernatant, and liquids from dewatering processes), the hydraulic conveyance used to transport them, and the location where they are reintroduced back into the treatment plant.

(2) Typical recycle flow in gallons per minute (gpm), the highest observed plant flow experience in the previous year (in gpm), design flow for the treatment plant (in gpm), the minimum plant rate (in gpm) during which the filter backwash will be recycled, and department-approved operating capacity for the plant where the department has made such determinations.

*b. Treatment technique requirement.* Any system that recycles spent filter backwash water, thickener supernatant, or liquids from dewatering processes must return these flows through the processes of a system’s existing conventional or direct filtration system as defined in 567—40.2(455B) or at an alternate location approved by the department by June 8, 2004. However, if capital improvements are required to modify the recycle location to meet this requirement, all capital improvements must be completed no later than June 8, 2006.

*c. Record keeping.* The system must collect and retain on file the recycle flow information specified below for review and evaluation by the department beginning June 8, 2004.

(1) A copy of the recycle notification and information submitted to the department under paragraph “a” of this subrule.

(2) A list of all recycle flows and the frequency with which they are returned.

(3) The average and maximum backwash flow rate through the filters and the average and maximum duration of the filter backwash process in minutes.

(4) The typical filter run length and a written summary of how filter run length is determined.

(5) The type of treatment provided for the recycle flow.

(6) Data on the physical dimensions of the equalization and treatment units, typical and maximum hydraulic loading rates, type of treatment chemicals used including average dose and frequency of use, and frequency at which solids are removed, if applicable.

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